

# WCB ENGINEERING BULLETIN

The Institution of Certificated Mechanical and  
Electrical Engineers  
Western Cape Branch (WCB)  
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MISSION STATEMENT : 1. To uphold the image and status of the Certificated Engineer. 2. To represent the Certificated Engineer at ECSA and other decision-making bodies concerning legislation, safety & health standards, the environment and the machinery regulations. 3. To promote continued education and training of its members and future engineers. 4. Promote fellowship in the engineering profession.

## Editorial

This last issue of the year will not have sample examination answers. We hope that these answers have been of help to those writing the Certificate exams. We suspect that our qualified members have peeped into these solutions to refresh their memories. In this issue we have a technical article Power Factor Correction harmonics which will have to be spread over two or three issues. Verbatim extracts of a talk on advances in computer technology is also included.

It is with regret that our local committee is losing one of the hardworking, enthusiastic and volatile members in Richard Murphy. Although extremely busy in his vocation as National Technical Services Manager of Old Mutual Properties, he made time for the interests of ICMEE both at Council and local level. We know he will not lose his concern that the Certificate will be firmly entrenched in legislation and that the Cert Eng will be recognised by users of machinery as the right man to maintain their machinery in a sound operating condition and safe for their employees.

We welcome our third Patron Cape Automation Systems CC and the twentieth Affiliate Ivar Kvale. We would like this Bulletin to reflect the activities of these associates, and any notes of information or news would be welcomed. These can be e-mailed or faxed to the editor at any time. The next issue is due at the beginning of February 1998.

We thank Revere Thomson, the editor's son-in-law, for the excellent job he has made of the publishing of the Bulletin, including complicated drawings and mathematical equations, and even making artistic sketches to illustrate the text.

All that is left to do now is to wish our readers a Blessed Christmas Season with their families & a Hopeful New Year.

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## Local Branch News

Realising that this is our last Bulletin for 1997 makes one feel that yet another year "escaped" one. At the beginning of the year we had so many personal goals for our Institution. Reviewing these, one realises that painfully few of these goals and objectives were actually achieved. It only reminds you that life is so short and so few of the "things" you set out to do actually materialise. It reminds us that Life is a precious gift from our Creator and every opportunity to live life to the fullest should be grabbed with both hands.

We are living in a constantly changing society; the pressure to "make it" increases all the time while the rules change constantly. The very familiar and very descriptive term "rat race" comes to mind. The secret here seems to be to make sure one does not become a "rat", and to make sure one can distinguish between what is really important in life & issues of secondary importance. In my book the primary issues are the "long term" issues of permanent substance such as one's personal relationship with our Creator and Saviour, one's loved ones and fellow men.

We have had a number of interesting factory visits, talks, etc. locally and we have seen many hours of head scratching, discussions, negotiations, etc. at local council level and between Council, ECSA and DOL. All with the ultimate objective of ensuring a safer working environment, and that the Certificated Engineer, who is responsible for ensuring a safer workplace on ground level, gets proper recognition for his role in the engineering profession. We want to thank our local committee and Council members, who volunteered their own free time for this, as well as our sponsors and Patrons.

At our last General meeting the following structure and committee for 1998 were approved:

Members re-elected: H Muller (Chairman)  
C Schnehage (Mrs) (Secretary)  
C Schnehage  
J Pereira  
J Horne  
M Lyle  
S Venter

New members (pending their acceptance):

Corporate members: Mr Salie (ad-hoc until membership approved)

Mr W Du Toit (member)

Ad-hoc members – non voting:

Term appointment: Mr Wichems (WP Technical College)  
Mr Atkinson-Hope or Mr Klue  
(Cape Technikon - pending acceptance)

Affiliate member – non voting:

Mr C Potgieter  
Mr D Arnold

Patron member – non voting:

Mr M Buckner

More about our plans for 1998 in the next issue.



# FATAL VAPOUR EXPLOSION

A supervisor and three labourers made preparations to clean a concrete water tank (actually a sump) which was 12 m above ground. The three workers climbed to the top of the tank whilst the supervisor went to fetch a rope and buckets. Whilst he was in the workshop a dull thud occurred and when he went to investigate he could not find the workmen. Smoke was coming out of the openings in the tank and he assumed they were inside. The fire brigade was summoned and they found the bodies of the three men inside the tank which was 1.7 m in height.

Later investigation showed that hydrocarbon vapour had entered the tank and as matches (though unburnt) were found it was assumed that someone had tried to smoke. Two of the bodies showed burns around the necks. A vapour/air concentration by volume of less than 6.9% would be explosive. Vapour tests by the Fire Department proved that vapour was present immediately after the event.

It was found that a condenser in which cooling water condensed the hydrocarbon vapour to a liquid solvent had seven leaking copper tubes and four which had been plugged off. When the plant is shut down it is possible for vapour to enter the water space and be carried into the water tank at start up. Vapour, dissolved in water which settled in the sump, could come out of solution, depending on ambient temperature, and collect in the space left when the water was drained for cleaning purposes. During operation it was not possible for vapour to enter the water because the latter was under pressure while the vapour was under vacuum.

Two years before the condenser had been tested for leaks and found satisfactory. No records were kept of inspections and tests and no one knew when the four tubes were plugged off.

COMMENT: Although it could not be anticipated that the vapour would enter the water tank, the poor condition of the condenser was a bad reflection on the engineering facility. As it passed a vapour which could become flammable or explosive, it should have been maintained fit for the service for which it was provided. Had this been done the accident could not have occurred.

The workmen thought they were far removed from dangerous vapours and can hardly be blamed for wanting to light up a pipe (later found on top of the tank).

This incident shows that equipment should be maintained fit for purpose as deviation from such fitness can bring unexpected surprises, sometimes ending in tragedy as in this case.



## Occupational Health & Safety Act No. 85 of 1993

### Issue no. 9

The Regulations which were promulgated in terms of Section 43 of the Act will be dealt with in this and the following issues.

#### GENERAL MACHINERY REGULATIONS (In force from 5 August 1988)

##### GMR 2(1)&(3) : Supervision of Machinery

The employer or user is required to appoint a Competent Person as defined to supervise machinery.

The qualifications of these persons depend on the power used on the premises.

- Up to 1200kW: an apprenticeship or 5 years practical experience

in an engineering trade, one year of which relates to the class of machinery he will supervise.

- >1200 and <3000kW: minimum qualification T3 or N5.
- 3000kW or more: a graduate engineer with 2 years' postgraduate experience and passed an examination on the Act and Regulations, or is a Certificated Engineer.

In the case of distribution of electricity the above categories are respectively:

- 3000 kVA MD or less;
- >3000 kVA MD and <10 000 kVA MD
- 10 000 kVA MD

These appointments must be made in writing and a copy of the letter of appointment sent to the Provincial Director.

Steam output is assessed by dividing the evaporative capacity (in kg/hr at 100°C) by 21 to obtain kW.

Machinery put out to contract is not included in the above ratings and the user is not required to appoint a Competent Person to be in charge of such machinery. The contractor is deemed to be the user and must make the appointment.

GMR 4(5): Unexpectedly setting a machine in motion or making a circuit electrically alive requires the user or operator to take precautions so that people will not be endangered.

GMR 4(6): This subregulation places a legal duty on the following persons to stop a dangerous machine: supervisor / operator / employer / user.

GMR 5(1): Permits competent persons to work on moving machinery or electrically alive equipment.

GMR 7: The failure of a machine (which might have caused injury) must be reported. These failures may be:

- a machine running out of control (e.g. an elevator of which the safety gear has failed to stop the car);
- a falling or flying part;
- a pressure vessel that has unexpectedly released pressure;

It is not clear whether a boiler fired short of water is reportable, but it is advisable to do so because it could have been weakened.

GMR 8: Notifiable Substances. The substances and their tonnages are listed.



*Continued from page 1*

Due to constraints and developments in his professional life Mr Richard Murphy will not be available as committee member for 1998. Richard has served as committee member, Chairman and Council member for many years. We want to thank him for the contribution he has made over these years and wish him all the best for the future.

The committee wants to use this opportunity to wish all members, patrons and affiliates a very joyful Christmas and a Prosperous New Year.

Isaiah 9:6 For unto us a child is born, unto us a son is given: and the government shall be upon his shoulder, and his name shall be called Wonderful, Counsellor, The Mighty God, The Everlasting Father, the Prince of Peace. (KJV) .

Hein Muller ☐

# CASE STUDY: MEDIUM VOLTAGE POWER FACTOR CORRECTION- MUTUAL PARK

By Richard Pr Eng B Com National Technical Services Manager Old Mutual Properties

## INTRODUCTION

This case study draws the reader's attention to the importance of equipment selection in so far as switching medium voltage power factor correction capacitors.

In addition, the analysis of Mutualpark's electrical load profile is discussed with the selection of capacitor step sizes.

Design deficiencies are cited and discussed with solutions to these.

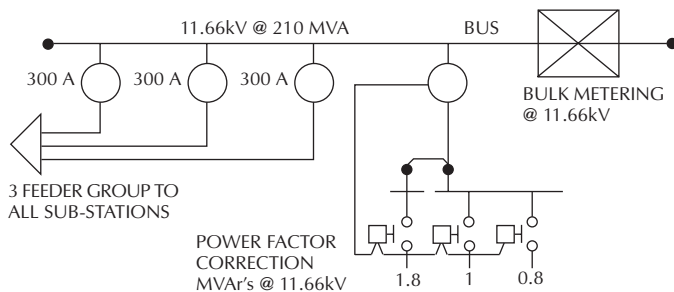
System resonance is calculated for the particular step sizes and related to the system fault level.

Graphical results show the benefit of power factor correction.

In 1987 an investigation was carried out to compare MV power factor correction to LV power factor correction. Nine substations were spread around Mutual park and the maximum demand was 5,12 MVA. The main substation is supplied at 11,66 kV via a three feeder group.

The exercise indicated MV PF correction was the correct option and was subsequently installed. The installation was commissioned in 1987 and showed immediate savings in the MD.

## Electrical reticulation schematic



The load profile curve of Mutualpark has a natural base load with a "Table Mountain" type demand sustained over a normal operational day. Load factor varies between 58 and 62% each month. Instantaneous starting peaks on refrigeration equipment add a small ripple to the MD profile, but do not represent more than 3% of the measured instantaneous MD.

The base load currently stands at 3.8 MVA with peak reaching 9.6 MVA corrected. In 1987 the base load was 2.6 MVA with a peak of 5.12 MVA. The base load comprises computer loads running 24 hours a day, with the associated uninterrupted power supplies, refrigeration plant, etc.

Calculated fault levels are 10.4 kA @ 11.66 kV. In 1987, at the time of the first phase PF installation, the fault levels were approximately 8.4 kA @ 11.66 kV. The difference in these values is as a result of a new step down major sub-station supplying Mutualpark at 11.66 kV. The current installed reactive power at Mutualpark is 3.6 MVAR.

Resonance is calculated by using the following formula, which relates the reactive power consumption to the fault level of the medium voltage system. The harmonic number at which resonance occurs can be determined by the formula:

$$n = \sqrt{\frac{S_{sc}}{S_{capacitor}}}$$

where: n = Harmonic Number

$S_{sc}$  = Calculated 3 phase fault level at the point of connection of the capacitors in MVA

$S_{capacitor}$  = Output at nominal system voltage of the proposed capacitor bank in MVAR

The rated capacitive bank voltage would be determined as follows:

$$V_{rated} = V_{50Hz} + \sum_{n=2}^{\infty} V_n$$

where n = harmonic number

$V_n$  = voltage at harmonic number n

$V_{50Hz}$  = fundamental system voltage

The rated voltage must allow for high system voltages at 50Hz as well as harmonic voltages and shall be at least 110% of the nominal system voltage.

The nameplate voltage that shall be assigned to individual capacitor units shall be at least the calculated "rated voltage"  $V_{rated}$  divided by the number of series groups of capacitor units in the proposed capacitor bank. The nameplate voltage shall exclude the allowance for permissible over-voltages stipulated in capacitor standard such as IEC 70.

The installed capacitor bank VAR's shall be the greater of the values obtained according to the following calculations:

$$a) \quad VAR = \sum_{n=1}^{\infty} I_n^2 X_n \quad b) \quad VAR = \frac{V_{rated}^2}{X_1}$$

where  $I_n$  = capacitor current at harmonic order n

$X_n$  = capacitor impedance at harmonic order n

$V_{rated}$  = capacitor rated voltage

$X_1$  = capacitor impedance at 50Hz

## CHOICE OF SWITCHING STEPS

The original switchgear at the medium voltage supply point comprised C7 oil switches that fell short of capacitor switching due to their inherent limitations of these restrike capabilities. This limited the use of the oil switches to clear a capacitor fault (phase to phase internal, or phase to earth) as restrike presents a catastrophic condition for capacitors. Consideration was then given to vacuum switching and SF6 switching.

## SWITCHGEAR LIMITATIONS

As indicated, oil switches of the vintage used at Mutualpark had no restrike capabilities because of the speed of the contacts opening which allowed re-energisation of the capacitor banks. Speed of 30% of normal speeds were recorded under independent test conditions.

Interlocking between modern medium voltage switches capable of switching capacitor banks and the vintage switches presented a problem during the early design phase of the project.

To be continued.



**NB** Please complete the enclosed "Certificated Engineer Survey!"

# Computers: 1981 to beyond 2000

Excerpts of a talk given by Trevor Roberts of PSCI Co to WPB of ICMEE on 28 August 1997

One has to talk around somebody's concepts. Somebody who is busy doing these things and delivering these things. Some of the points I am going to raise may come over a bit 'commercial'. It is really about what is going to happen with client server software and re-engineering maintenance operations. Firstly, technology changes and takes leaps and bounds. It is very important to stay on top of that; have your systems grow with that. I believe that the information age will start round about 2010 or 2020. What we have seen up till now about information and assimilating information is just the tip of the iceberg. To give you some idea what some of these companies are doing. The PSCI Company which is the largest; they turn around about 90 004 000 sizeable systems. They have been working in this high technology market since 1991. They started in 1968. They were the first ever company, in 1968, an independent company, to provide software, an independent software company. They provided the P2 Project Management System that some of you might know of. That is what was used to build the Sasol 2 and 3 Secunda project management system. They were the first company ever to release a project management system driven with a mouse back in the early 70's. You could not buy a mouse so they had to send it with the package. They were the first company to put a Windows Client Server product on the world market in 1991. There are the innovators, technology enthusiasts which lie here, wingers and pickers. You have them all in your own companies. They knew about the latest and greatest thing that was available. They get these square eyes from the internet. They can tell you anything that happens with technology. Sometimes you call them the sort of technology gatekeepers. Whenever new technology comes up they say, "Give it to Rodney". What happens as soon as one can start feeling that technology in your fingers, the visionaries start taking it up. These are the people that are driven by technology but they can see the vision. They are prepared to live with a bit of pain as long as they can get this in future. They really drive technology forward. They are called the earlier adopters. The early majority of people are the pragmatists. They are the people who say show me the stuff, show me the business benefit. You don't rub them up with technology. Then you get the sort of conservatives. They are the guys who just went out and bought an XT last week. Now it is proven technology. You only deliver your technology to the market when there are a lot of people who want to buy, who want to accept it. They want things that they can feel and see. They don't want promises. A lot of the things that I am showing you now lie in this area. Some of it is already migrating over. You will see some of the things coming onto the market from many different companies in the next 6 to 18 months. If you look at technology and where the future is going, you have got to look at one of the market drivers today. What happens on the market is that we all sit with critical capital assets.

There is a whole set of management trends pushing us towards working better with those assets and there is a lot of technology enabling us to do these things. Because of those forces onto people who maintain capital assets, it tends to push the technology forward much quicker than what it used to do about 10 years ago. That is why I believe that things like return on net assets, RONA, is going to be a much bigger drive for all of you over the next few years, where ROI and IRR and NPV were the main drivers who wanted to prove anything to anybody. One would ask 'how will it influence my RONA?', instead of 'What will the IRR be on that project?' This is really where we can go to. We can live in a world of virtual reality. Just think of a virtual reality maintenance. Instead of going down there you can sit here and have your problems brought to your chair. You can fix them or try them on or even train doing the stuff virtually and not on the real equipment; the people doing simulators, specifically in a nuclear environment and so forth. This technology will most probably be in the future for us. If we look back, what has happened? Batch processing started off a question of 14 years ago. In 1984, most software was done in a batch process. I can still remember getting my set of punch cards together and putting them

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in the hopper in 1981. By about 2 or 3 years later people all got hoppers with punch card machines at university; they were replaced and everybody had on-line terminals. On-line started in about 1984. The first IBM XT I saw was in about 1982. One of my colleagues said he was at university in Pretoria at that stage and when the first IBM XT arrived they all stood in a row to go and look at the 'beast'. This is a the Pentium Notebook. I think my Pentium II Notebook is about 4 times more powerful. There is a thing called Moore's Law. Moore says that the price performance ratio of computing is doubling every year. By next year we would buy the same power for half the price, for the same price get twice the power. I think that we all talk about the World Wide Web and the power that lies there. I don't know how many of you are avid surfers of the net. It's incredible the amount of information that you can get and the amount of maintenance

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information. I will show you the Web page name on the board for you now so that you can go and have a look at where they have got a place called the (industry.net) where they have information about equipment and suppliers about anything you can think of in the world. It is absolutely incredible, more information about what it is, where it is and what the numbers are. Just go in there and have a look. I think Bill Gates said that we are on the brink of a new revolution and crossing the technology threshold will even change the way we buy, work, learn and communicate with each other. What we see today is nothing compared to what is coming.

*To be continued*



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